An Approach to Selection of Third Party Reverse Logistics provider for Mobile Phone Industry using VIKOR Method

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Abstract— Reverse supply chain logistics is the transfer of goods from end users towards manufacturer in the way of product distribution. In these dynamic business scenarios, the companies must promote other uses of resources that may be economic and eco friendly by furnishing products' routine life cycles. RL activities i.e. Preserving, transporting and handling of used products ails a great challenge to reverse logistics executives as there is always chances of conflicted in terms of quality, quantity and time of return of EOL products in case of reverse supply chains. Business enterprises involving those of white/electronics goods manufacturing industries would strives to focus on their core competency areas and there is need of opting outsourcing decisions of their reverse logistics process to Third-Party reverse Logistics Providers (3PRLPs). Thus, most important strategic complication for top management is the evaluation and selection of third party logistics service provider who can effectively provide reverse logistics operation services to the firms. The significance of this work is to develop decision support system (DSS) to assist the top management of the company in selection and evaluation of best 3PRL service using VIKOR method.

Keywords— TOPSIS, Normalized decision matrix, Alternative criterion function, maximum criterion function, Utility measure, Regret measure, VikorIndex.

INTRODUCTION

Supply chain management systems have seen a dynamic change in operational style since last two decades. In earlierbusiness practices, supply chain flow happens in the forward direction only. In current business environment industries arefacing the problem of return flow of the products in the supply chain for a variety of reasons like product recalls, warrantyfailure, service failure, commercial returns, manufacturing returns, end-of-life (EOL) and end-of-use returns. Reverselogistics is the process of return product handling mechanism in forward supply chain.The productive utilization of 3PLS providers for reverse logistics activities may lead to enhancement of profit margin and effective integrated supply chain network for organizations. Therefore, a very important strategic issue for company management is the evaluation andselection of 3PL logistics service providers who can efficiently provide reverse logistics services to organization. In this paper, a hybrid approach VIKOR has been used for making strategic decision in multi-attributedecision environment for selection of 3PL service providers for collection of end-of-life (EOL) mobile phones. This paper organized as follows.

LITERATURE REVIEW

In this work, an attempt is made to discover the potential and applicability of Vikor (a ranking compromise) method while selecting the reverse logistics for a particular industrial application. VIKOR (the Serbian name is 'VlseKriterijumskaOptimizacijaKompromisnoResenje' which means multicriteria optimization (MCO and compromise solution) method was mainly Established by Zeleny [1] and later advocated by Opricovic and Tzeng [2-3]. This method is developed to solve the Attributes MCDM problems with conflicting and non-commensurable (different units criteria), assuming that compromise may be acceptable for conflict resolution, when the decision maker wants a solution that is the closest to the ideal solution and the alternatives can be evaluated with respect to all the attributes set.

METHODOLOGY

VIKOR (VlseKriterijumskaOptimizacijaKompromisnoResenje), also known as Compromise Ranking Method is a possible solution that is closest to the ideal solution and the meaning of compromise is agreement generated by mutual concession.The VIKOR MCDM approach presented in this work and applied in evaluation & selection of 3PL for a mobilephone manufacturing industry. There are 20 outsourcing service providers were interested to conduct reverse logistics operation for the cell manufacturing industry. In the preliminary screening 11 service providers were rejected easily by the company management. The final selection from the remaining nine potential 3PRLPs (A, B, C, D, E, F, G, H and I) was very tough task because almost all the service providers fulfill the requirement of the company. These attributes are E-Waste Storage Capacity (EWSC), Availability of Skilled Personnel (AOSP), Level of Noise Pollution (LNP) and Impacts of Environmental Pollution (IEP), Safe Disposal Cost (SDC), Availability of a covered and closed Area (ACCA), Possibilities to work with NGOs (PWNGO), Inspection/sorting and disassembly cost (ISDC), Mobile phone Refurbishing cost (MPRC), Mobile recycling cost (MRC). Among these attributes, ISDC (thousands of Rupees), EWSC (in tones), MPRC (INR/hour), MRC (thousands of INR) and final disposal cost (thousands of INR) are quantitative in nature, having absolute numerical values. Attributes AOSP, LNP, ACCA, IEP and PWNGO have qualitative measures and for these a ranked value judgment on a scale of 1–5 (here 1 corresponds to lowest, 3 is moderate and 5 corresponds to highest) has been recommended. The cost of recycling of EOL or used mobiles phones ranges from INR.1000 to INR.1600 per unit and INR.1200 to INR.2000 per unit for safe disposal of hazardous waste from mobile. A single mobile refurbishing technician can test and troubleshoot a used mobile, make necessary repairs and upgrade and package it for reuse in 3 hours at a cost of on an average INR.1500 (Techsoup, 2008). These data was provided by various remanufacturing companies during this research project and has been used as the reference for the formulation of reverse logistics data for the case company dealt inthis work. The data for all 3PL with respect to various attributes.

The calculation of VIKOR values, we go through the following steps:

Step 1: In the first step, we have to determine the objective and to identify the attribute values for each alternative.

Step 2: Establish the decision matrix

The first step of the TOPSIS method involves the construction of a Decision Matrix (DM).

$$DM = \begin{array}{c} \\ L_1 \\ L_2 \\ \vdots \\ L_m \end{array} \begin{array}{c} \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad \text{----------------- (1)}$$

Where 'i' is the criterion index (i = 1 . . . m); m is the number of potential sites and 'j' is the alternative index (j= 1 . . . n). The elements $C_{1,}$ $C2_{...,}$ C_n refer to the criteria: while L_1, $L_{2...,}$ and Lnrefer to the alternative locations. The elements of the matrix are related to the values of criteria i with respect to alternative j.

Step 3: Calculate a normalised decision matrix

The normalized values denote the Normalized Decision Matrix (NDM) which represents the relative performance of the generated design alternatives.

$$\mathrm{NDM} = \mathrm{R_{ij}} = \frac{\mathrm{x_{ij}}}{\sqrt{\sum_{i=1}^{m} \mathrm{X^2}_{ij}}} \quad \text{----------------(2)}$$

Step 4: Depending upon the relative importance of different attributes obtain weight for each attributes using the formula given below and the sum of the weights should be 1.

$$W_j = V_j / \sum_{i=1}^{m} V_j \ \ \& \ \ \sum_{j=1}^{m} w_j = 1 \quad \text{----------------- (3)}$$

Step 5: Obtain the value of the criterion function for all the alternative f_{ij}. $f_{ij}$is the j_{th} criterion function of X_i alternative .

Here, i=1, 2… n: the number of alternatives.
j=1, 2… m: the number of criteria.

Step 6: Obtain the maximum criterion function f j* and the minimum criterion function f j- , where j = 1. . . . . . m.

$$f_j^* = \max_i f_{ij} = max\ [(f_{ij})|\ i = 1, 2, ...,n] \quad \text{------------------- (4)}$$

$$f_j^- = \min_i f_{ij} = min\ [(fij)\ |\ i = 1, 2, ...,n] \quad \text{-------------------- (5)}$$

Step 7: Calculate the utility measure and regret measure for all the alternatives given as:

a) Utility measure

$$S_i = \sum_{j=1}^{m} W_j (f_j^* - f_{ij})/(f_j^* - f_j^-) \quad \text{------------------ (6)}$$

b) Regret measure

$$R_i = \max_j \left[W_j (f_j^* - f_{ij}) / (f_j^* - f_j^-) \right) \quad \text{------------------ (7)}$$

Step 8: Calculate the value of VIKOR index for each alternative expressed as follows:

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1 - v)(R_i - R^*)/(R^- - R^*) \quad \text{-------------- (8)}$$

Where,
Qi represents the VIKOR index value of i_{th} alternative. I=1,2,……,n

$$S^* = \min_i S_i = min\ [(S_i) \mid i = 1, 2, \ldots\ldots, n]$$

$$S^- = \max_i S_i = max\ [(S_i) \mid i = 1, 2, \ldots\ldots, n]$$

$$R^* = \min_i R_i = min\ [(R_i) \mid i = 1, 2, \ldots\ldots, n]$$

$$R^- = \max_i R_i = max\ [(R_i) \mid i = 1, 2, \ldots\ldots, n] \quad \text{-------------------- (9, 10, 11, and 12)}$$

V is the weight for the maximum value of group utility and 1 – v is the weight of the individual regret. v is generally set to 0.5.

Step 9: Rank of the alternatives is done by observing the Qi value. The less the value indicates a better quality.

INPUT TABLES

Table 1: AHP Measurement Scale

	Numerical rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderate preferred	3
For compromise	2,4,6&8
Equally preferred	1

Table 2: Decision matrix

3PRLSP	EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
A	150	160	130	1200	1400	3	4	3	4	5
B	140	170	150	1300	1800	5	5	4	3	4
C	170	160	180	1350	1480	4	3	5	5	5
D	180	165	160	1500	1600	2	3	3	1	2
E	110	150	160	1500	1400	1	3	5	2	5
F	120	180	130	1400	1400	5	3	4	4	2
G	130	165	150	1300	1750	3	2	4	3	5
H	200	160	130	1550	1800	4	1	2	4	4

I	150	110	140	1200	1650	5	2	2	4	5
sum	1350	1420	1330	12300	14280	32	26	32	30	37

RESULTS TABLES

- Normalized decision matrix

Table 3: Normalized decision matrix

3PRLSP	EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
A	0.11111	0.112676	0.097744	0.097561	0.098039	0.09375	0.153846	0.09375	0.133333	0.135135
B	0.10374	0.119718	0.112782	0.105691	0.12605	0.15625	0.192308	0.125	0.1	0.108108
C	0.125926	0.112676	0.135338	0.109756	0.103641	0.125	0.115385	0.15625	0.166667	0.135135
D	0.133333	0.116197	0.120301	0.121951	0.112045	0.0625	0.115385	0.09375	0.033333	0.054054
E	0.081481	0.105634	0.120301	0.121951	0.098039	0.03125	0.115385	0.15625	0.066667	0.135135
F	0.088889	0.126761	0.097744	0.113821	0.098039	0.15625	0.115385	0.125	0.133333	0.054054
G	0.096296	0.116197	0.112782	0.105691	0.122549	0.09375	0.076923	0.125	0.1	0.135135
H	0.148148	0.112676	0.097744	0.126016	0.12605	0.125	0.038462	0.0625	0.133333	0.108108
I	0.111111	0.077465	0.105263	0.097561	0.115546	0.15625	0.076923	0.0625	0.133333	0.135135
$X^{*}_{ij\ mean}$	0.111111	0.111111	0.111111	0.111111	0.111111	0.111111	0.111111	0.111111	0.111111	0.111111

- Variance of different attributes

Table 4: Variance of different attributes

EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
0.000533	0.00022	0.00019	0.000127	0.000167	0.002263	0.002301	0.001426	0.001905	0.001345

- Weights of different attributes

Table 5: Weights of different attributes

EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
0.050861	0.020994	0.018152	0.012164	0.015896	0.215949	0.219572	0.136077	0.181752	0.128337

- Maximum criterion function

$$(f_j^* = \max_i f_{ij})$$

Table 6:Maximum criterion functions

EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
0.148148	0.126761	0.135338	0.126016	0.12605	0.15625	0.192308	0.15625	0.166667	0.135135

- Minimum criterion function

$$(f_j^- = \min_i f_{ij})$$

Table 7: Minimum criterion function

EWSC	ISDC	MPRC	MRC	SDC	ACCA	PWNGO	AOSP	LNP	IEP
0.081481	0.077465	0.097744	0.097561	0.098039	0.03125	0.038462	0.0625	0.033333	0.054054

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- Utility measure

$$(S_i = \sum_{j=1}^{m} W_j (f_j^* - f_{ij})/(f_j^* - f_j^-))$$

Table 8: Utility measure

A	B	C	D	E	F	G	H	I
0.37949	0.2355	0.206393	0.705303	0.546802	0.413392	0.474513	0.522005	0.428092

S* = 0.206393; S- = 0.705303

- Regret measure

$$(R_i = \max_j [W_j(f_j^* - f_{ij}) / (f_j^* - f_j))$$

Table 9: Regret measure

A	B	C	D	E	F	G	H	I
0.107974	0.090876	0.109786	0.181752	0.215949	0.128337	0.164679	0.219572	0.164679

R* =0.090876; R- =0.219572

- VIKOR Index value

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1 - v)(R_i - R^*)/(R^- - R^*)$$

Table 10: VIKOR index value Qi

	A	B	C	D	E	F	G	H	I
Qi	0.239905	0.029171	0.073468	0.853064	0.827076	0.352992	0.555439	0.816301	0.508917
Rank	7	9	8	1	2	6	4	3	5

CONCLUSION

The analysis and selection of the 3PL for mobile industry is a management level strategic decision. The amount of e-waste is enormouslyescalating and it poses complicated to society and environmental burden. The electronics appliances manufacturing companies are quite interested to focus towards their core competencies and services of 3PL is a right choice for them to separate reverse logistics operations. Therefore, hiring the services of 3PL is an importance issue and present work is very significant in this regards.The manufacturing industries does not have enough competence to manage their product reverse flow in supply chain, thus they have to only option to outsource their reverse logistics operations to the 3PL service provider for conduct of reverse logistics (RL) activities. Finally, the TOPSIS method is employed to evaluate the best 3PRL service provider considering various criteria's.The results showthat 3PRL service provider 'D' is most suitable among all other service providers. Least preference is given to service provider 'B' according to its ranking.

FUTURE SCOPE

The scope of present work may be carried for evaluating 3PRL Service provider using other MCDM techniques especially Fuzzy-TOPSIS, Grey Relational Analysis, ANP, Promthee, Electree, Multi goal Programming (or) Multi objective decision making and hybrid Techniques.

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